Frontal Dynamics In The Middle Atlantic Bight: Analysis Of Seasoar Data From The Onr Shelfbreak Primer Experiment

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LONG-TERM GOAL

The goal of the Shelfbreak PRIMER frontal component is to investigate the dynamics of shelfbreak processes relating to variability of the thermohaline and velocity structure near the front. We are also pursuing collaborative research with acousticians on how this oceanographic variability affects acoustic propagation between the continental shelf and continental slope.

OBJECTIVES

We are presently analyzing the SeaSoar data collected during the Shelfbreak PRIMER experiment to examine how the shelfbreak front responds to offshore forcing via slope eddies and wind forcing. We are also exploring the structure of the upwelling and downwelling cells associated with the front, and how they are affected by frontal meandering.

APPROACH

The Shelfbreak PRIMER data set provides a unique opportunity to map the dynamically important variables such as relative vorticity and potential vorticity in three dimensions at the shelfbreak front in the Middle Atlantic Bight. During the summer and winter cruises, we can also examine the temporal evolution over daily time scales as the front meanders and responds to wind forcing.

WORK COMPLETED

1) The data from the spring cruise has been analyzed. A slope eddy with a diameter of 35 km was located just offshore of the front and strongly affected the frontal structure. The presence of the eddy lead to significant alongfront accelerations of the frontal jet, with maximum alongshelf velocities going from 20 cm/s to 70 cm/s over 40 km in the alongshelf direction (Gawarkiewicz et al., 1999). There were several bands of divergence and convergence within the frontal zone on cross-shelf scales of 10 km, suggesting several upwelling and downwelling cells are present within the frontal zone.

2) In collaboration with acousticians from the PRIMER program, we have analyzed the effect of frontal variability on internal solibore characteristics (Colosi et al., 1999), on acoustic propagation through the front (Sperry, 1999), and on how seasonal changes in frontal structure affects acoustic propagation across the front.

3) Using insights gained from the PRIMER field program, a retrospective Lagrangian study of the frontal jet established that the exchange between the shelf and slope is fairly evenly distributed throughout the Middle Atlantic Bight and is not concentrated at canyons or other special sites, and that detrainment from the jet is concentrated offshore to the continental slope (Lozier and Gawarkiewicz, 1999). Further, the continuity of the jet between the south flank of Georges Bank and Cape Hatteras was also established.

4) Further mapping and analysis of the summer and winter data sets has also taken place, including some estimates of the vertical velocities during the summer.

RESULTS

The most important result to date from the analysis involves the degree to which slope forcing is important to the structure and dynamics of the front. During the spring, the slope eddy which was present had 30 cm/s onshore flows on one side and 20 cm/s offshore flows on the other side. The asymmetry of the flows lead to a steepening of the isopycnals on the onshore (western) side of the eddy and flattening of the isopycnals on the offshore (eastern) side of the eddy. (Figure 1) This was associated with an accelerated baroclinic, surface trapped current on the western side of the eddy, and a weak surface trapped current on the eastern side of the eddy. A strong convergence zone was located near the surface outcrop of the front, with estimated vertical velocities of 20-30 m/day and a cross-shelf scale of 10 km. In addition, a strong nearly barotropic jet was located near the foot of the front which had maximum velocities as large as 45 cm/s. The slope eddy was also important in driving eastward flows just seaward of the front, which enhanced the lateral velocity shear associated with the frontal jet. The most fundamental result is that the spatial decorrelations are on the order of 10 km and the temporal decorrelation scale is order 1 day, and thus the shelfbreak is a highly dynamic and variable environment.

IMPACT/APPLICATIONS

These results suggest that strong, highly sheared flows are common at the shelfbreak and that the small spatial and time scales make measurement of exchange between the shelf and slope difficult.

A knowledge of the proper time and space scales of variability is important in obtaining better estimates of acoustic transmission and loss between the continental slope and shelf.

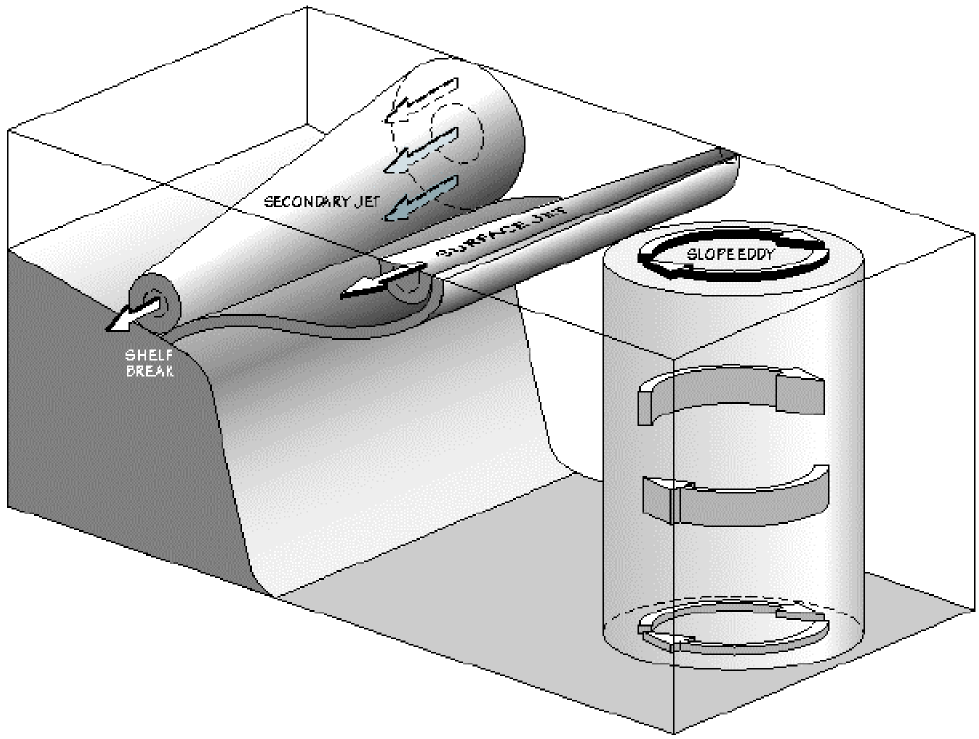

Figure 1- A schematic diagram of a slope eddy interacting with the baroclinic jet in the shelfbreak front. On one side of the eddy, the flow is onshore, and the baroclinic jet is deep and strong. On the other side, the flow is offshore, which weakens the jet. A strong flow near the foot of the front was also observed.

TRANSITIONS

There are no transitions at this point.

RELATED PROJECTS

We have interacted with a large number of investigators from the Coastal Mixing and Optics experiment on slope intrusions onto the shelf and other relevant processes. We have also been using some of our results to gain further insight into shelfbreak structures off the east coast of Korea and have interacted with physical oceanographers and acousticians working in that area. We have also participated in planning exercises for shelfbreak exchange in the Arctic as part of the

Shelf-Basin Interaction program. Finally, we will be deploying an isopycnal float in the shelfbreak front to try and get some indication of vertical velocities from direct Lagrangian measurements (in collaboration with B. Owens of WHOI).

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Colosi, J., J. Lynch, R. Beardsley, G. Gawarkiewicz, and A. Scotti, 1999. Observations of nonlinear internal waves on the New England continental shelf during summer Shelfbreak PRIMER. Submitted to *J. Geophys. Res.*

Lozier, M., and G. Gawarkiewicz, 1999. Cross-frontal exchange in the Middle Atlantic Bight as evidenced by surface drifters. Submitted to *J. Phys. Oceanogr*.

Sperry, B. Analysis of acoustic propagation in the region of the New England continental shelfbreak, 1999. Ph.D. thesis, MIT/WHOI Joint Program in Applied Ocean Physics and Engineering.

PUBLICATIONS

Gawarkiewicz, G., F. Bahr, R. Beardsley, and K. Brink, 1999. Interaction of a slope eddy with the shelfbreak front in the Middle Atlantic Bight. Submitted to *J. Phys. Oceanogr.*

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